

**PNGV - A Government/Industry Partnership Experiment**  
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Clean and Efficient Transportation

Memo: And Affordable,  
Desirable and Reliable

*Partnership for a New Generation of Vehicles*

## Outline



- Background, Organization and Timing
- Environmental Trade-offs
- Current Status
- Summary

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## PNGV Background

- A Cooperative R&D Program between the Federal Government and USCAR
- Agreement between President Clinton and Chairmen of Ford, General Motors and DaimlerChrysler
- To Substantially Improve Fuel Economy and Enhance Industry Productivity and Competitiveness

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## PNGV is a Historic Partnership

- Partnership between government and industry for mutual benefit
  - Increase energy efficiency
  - Improve environmental quality
  - Enhance national competitiveness
- Demonstration that economic security and environmental quality can be mutually supportive and achievable
- Belief that R&D collaboration is the most effective way to develop the technology needed

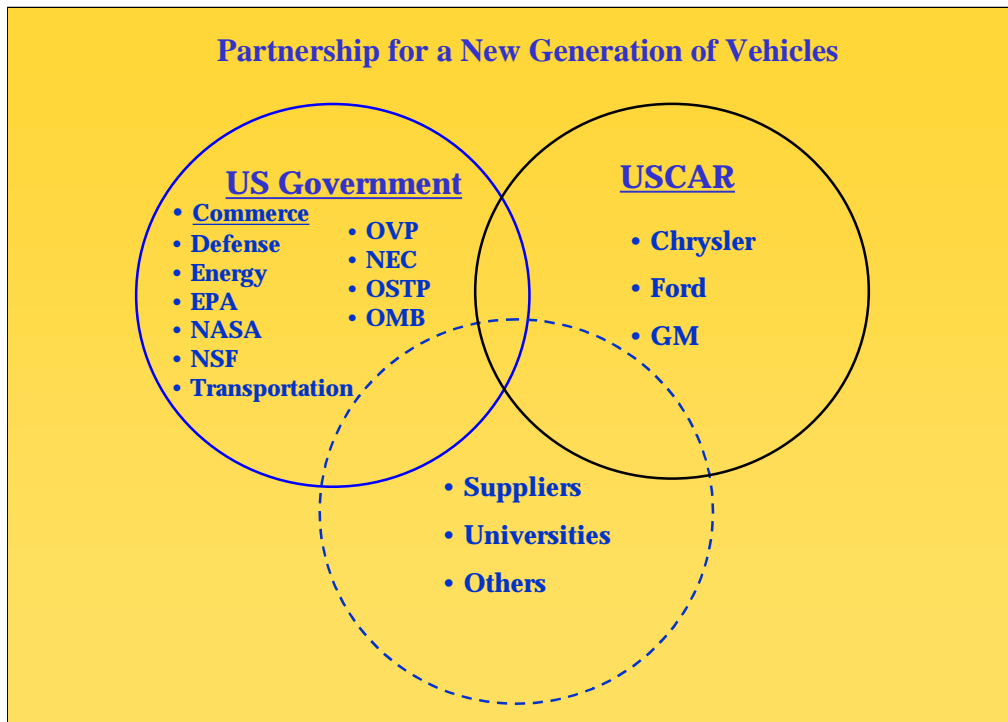
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## Coopetition: A New Concept



- **Requires a Common Opportunity**
- **Needed to Solve National and Global Problems**
- **Criteria**
  - Pre-competitive activity only
  - Areas of Limited Product Differentiation
  - Involve Common Suppliers/Sources

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Let me explain who is in this Partnership and how it came about.

The Big 3 began forming R&D consortia in 1988, which became so numerous that USCAR was formed

Then USCAR joined with the US gov't to do PNGV:

7 technical federal agencies and 4 policy organizations in the White House, led by the OVP.

That represents a lot of talent! Over 100,000 engineers & scientist in abt 25 major R&D centers

But it's not enough. Execution of the program will require the participation of the supply base and our academic sector.

## Research Goals



### ■ Manufacturing (Goal 1 - U.S. Competitiveness)

- Reduce manufacturing production costs and product development times for all car and truck production

### ■ Near-Term: Conventional Vehicles (Goal 2)

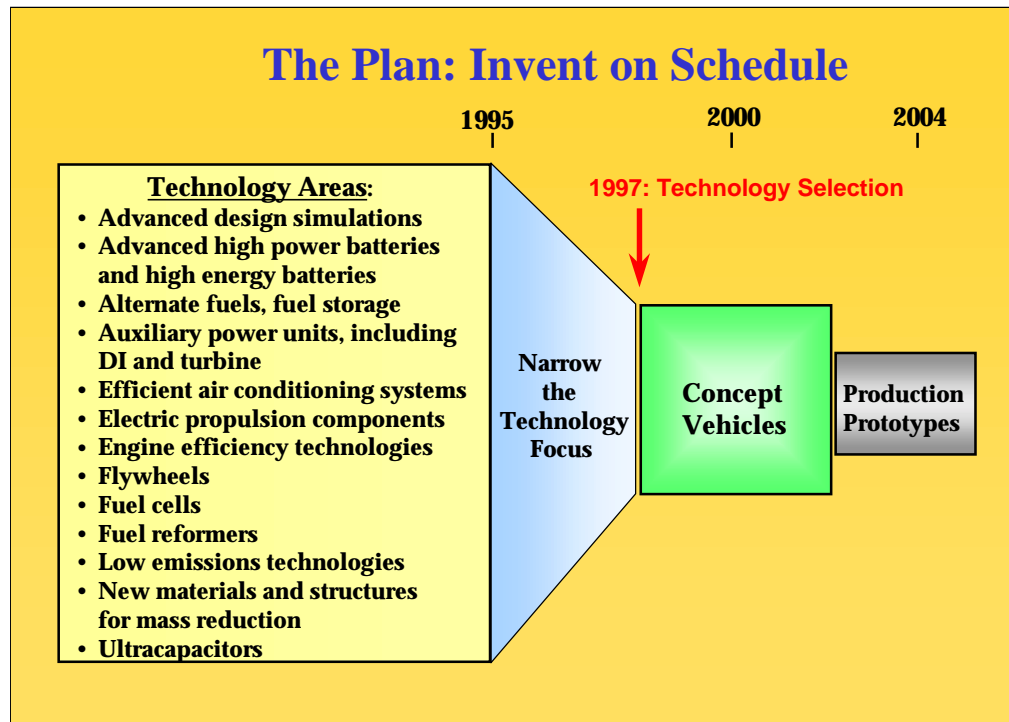
- Pursue advances that increase fuel efficiency and reduce emissions of standard vehicles of today's fleet

### ■ Long-Term: New Generation Vehicle (Goal 3)

- Develop a new class of vehicle with up to three times the fuel efficiency of today's comparable vehicle (80 mpg/Taurus sized car)

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Let's talk about what the Partnership agreed to as technical goals: (read chart)



### Original intent

Convergence and focusing of resources

Development and validation in a system context, with Industry leadership in selecting technologies

Continued development of winning component technologies

### Emerging Realities

Realization that some/many technologies of interest require longer time-frames

Evolving consensus on roles of government and industry

Recognition that resource constraints have made task of achieving affordable 3X goal in 10-year timeframe more challenging

Recognition of difficulty in building & sustaining decade-long political support



## The Downselect Technologies



### ■ Light weight materials

- Reducing mass improves both fuel economy and emissions, regardless of propulsion system

### ■ 4SDI engines

- Direct injection offers 15-35% improvement in efficiency

### ■ Electric traction

- Electric traction enables hybrid propulsion or fuel cell propulsion

### ■ PEM fuel cells

- Potential for low emissions and high efficiency

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## Environmental Trade-offs

- Examples of the historical trade-off between fuel efficiency and exhaust emissions utilizing a given technology
  - Catalyst
  - 3-way Catalyst
  - Fuel Injection
  - Computer controls
- Unaffordable technology prevents widespread adoption
- Customer preferences often do not correspond with their environmental concerns

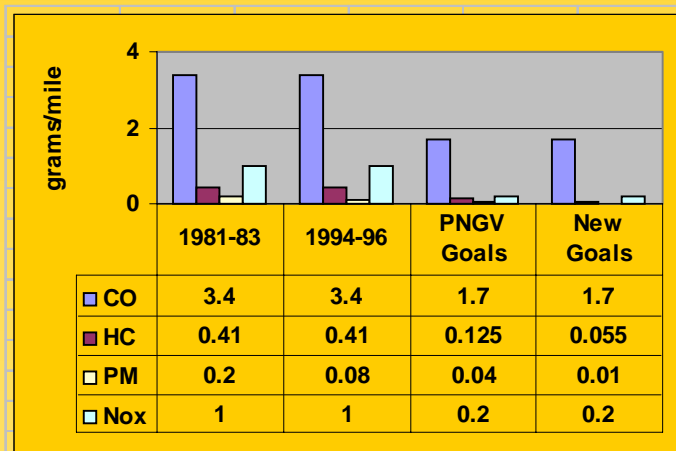
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## CIDI Emission Issues

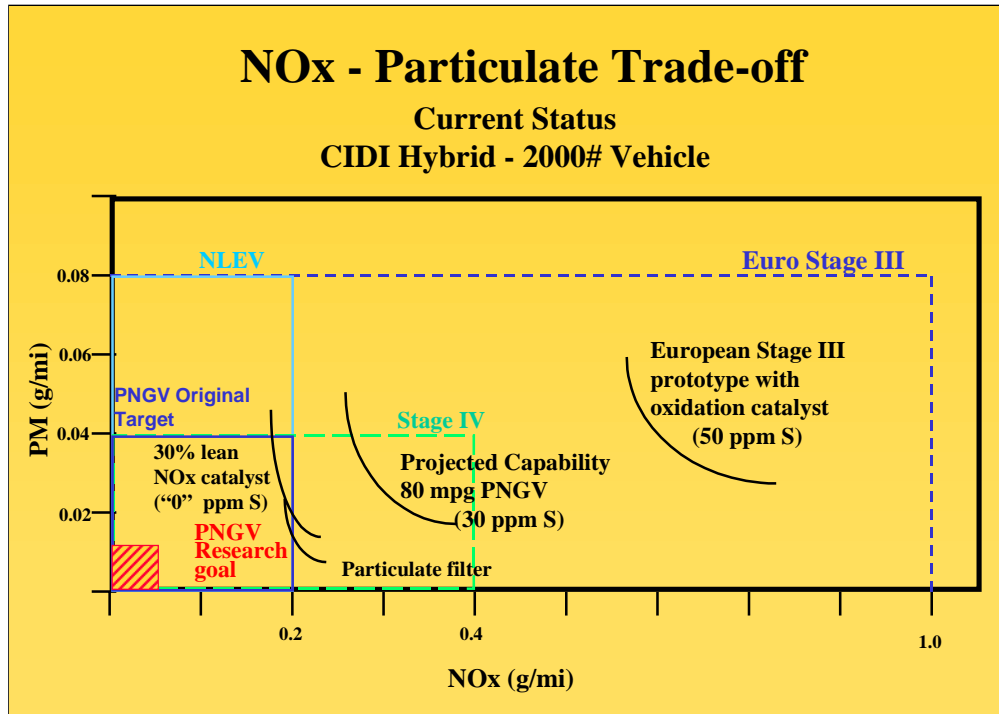
- Combustion control, aftertreatment and fuel improvements are required
- Fuel Economy/Emissions Trade-off
  - High engine combustion efficiency creates  $\text{NO}_x$
  - Controls to reduce HC or improve catalyst performance usually hurt fuel economy
- Future Standards
  - If too stringent, CIDI use may be prohibited
  - Fuel regulations may be required to meet emissions

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## Emission Standards and PNGV Targets Keep Changing



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When PNGV started, we realized that along with improving fuel economy, the next generation of vehicles would have to be cleaner than today's vehicles. Our target was set at Default Tier 2, shown on the chart in gold. Default Tier 2 was considered at that time to be a stretch especially with the "downselected" engines. In 1998, PNGV accepted a 0.01 particulate goal as a research target. But recent CARB LEV II and EPA Tier 2 rules have shrunk the playing field considerably. These levels are extremely difficult to meet for gas engines, let alone diesels. (also difficult to measure)

## Positive Results To-date

- Partnership Established: Industry/Government/Suppliers
- Comprehensive, Extensive Technology Review Completed
- Most Promising Technologies Selected
- Concept Vehicles Being Built - Competitively

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## Specific Technical Progress



- Four-stroke Direct Injection Engines
  - Emissions, noise, weight all improved
- Fuel Cells
  - Major improvement in all parameters
- Batteries
  - Specific designs for hybrid application being developed

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## Specific Technical Progress (Cont'd.)



- Power Electronics and Electrical Systems
  - Substantial cost reduction
- Materials
  - Lightweight components developed using a variety of new materials
- Manufacturing Processes
  - New processes developed for new components and materials

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## Major Barriers to Meeting Goal 3

- Cost
- Emissions Capability
- Fuel Cell Maturity/Performance
- Developing a viable Fuel Strategy
- Battery Performance

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## Partnership for a New Generation of Vehicles Summary



### ■ Benefits

- Common state-of-the-art knowledge has been established
- Technical & business resource commitments have been increased
- Suppliers have become involved
- Some technology has been introduced earlier

### ■ Unresolved Challenges

- Full participation of all stakeholders
- A mechanism to develop technically and economically sound policies to achieve societal goals

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